

An Anatomical Study of Superficial Palmar Arch and its Clinical Significance

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Abstract: *Background:* Superficial palmar arterial arch is a dominant vascular structure of the palm. It is defined as an arterial arcade, formed by superficial branch of the ulnar artery and completed on lateral side by the superficial palmar branch of the radial artery or Arteria radialis indicis or Arteria princeps pollicis or arteria nervimediana. Variations can occur in the vessels contributing to the formation of superficial palmar arch (SPA). *Aim:* The main objective of the study is to know the formation of superficial palmar arch and different types of formation with an emphasis on its clinical relevance. *Result:* The present study was conducted on 50 specimens, following the classification of Coleman and Anson. We found complete arch of type A in 43 hands (86%) and of type B in 3 hands (6%). In this study incomplete arch was seen in 4 hands (8%, 1 right and 3 left), persistent median artery type H supplying the radial side of the palm and digits was seen in only one hand (2%). *Conclusion:* Knowledge of such variations is of immense help for microvascular surgeons, plastic surgeons and orthopaedicians to bring a better outcome in their surgical procedures. Also, it will be helpful for cardiovascular surgeons to carry out radial artery harvesting procedures for the purpose of Coronary Artery Bypass Grafting.

Keywords: Complete, Incomplete, Coronary Artery, median artery, superficial palmar arch, ulnar artery.

1. Introduction

Arterial supply to the man's hand is most important as the hand is an earning tool. It is derived from two anastomotic arches, superficial palmar arch and deep palmar arch formed by the anastomosis between main arteries of the hand that is radial and ulnar arteries and their branches in the palm. The SPA is a dominant vascular pattern of the palm. It is located just deep to palmar aponeurosis and superficial to digital branches of median nerve, long flexor tendons of the forearm and lumbricals of the hand. About two third of the SPA is formed by superficial branch of ulnar artery alone, remaining one third by superficial palmar branch of either arteria princeps pollicis or the median artery [1]. Four digital arteries arise from the convexity of the arch and pass to the fingers. The most medial artery supplies the ulnar side of the little finger called proper digital artery and the remaining three common palmar digital arteries subdivide into two and supplies the contiguous sides of the little, ring, middle and index fingers respectively [2]. Developmentally lateral branch of seventh inter-segmental artery communicates with axis artery developing in situ in upper limb bud. This axis artery is represented by axillary, brachial, and interosseous arteries. The interosseous artery continues into hand plexus, and forms deep palmar arch. The ulnar, median, and radial arteries sprout from axial artery. Median arteries that sprout from axis artery usually accompany median nerve in hand and forms superficial capillary plexus. Median artery regresses, loses its distal connection and superficial palmar plexus is fed by communication of the ulnar artery with the plexus to form the arch. A detailed study of the functions of the hand is the basic requirement of all aspiring hand surgeons. This is an unfortunately a highly complex matter and though general guidelines can be given, continued clinical experience and observations are necessary if treatment regime are put forward for the best advantage to the patient. Awareness and

identification of the SPA variation in the hand is critical for orthopaedicians and micro – vascular surgeons performing advanced surgical procedures such as arterial repairs vascular applications. The knowledge of variations of vascular patterns of hand gained more importance in microsurgical techniques, reconstructive hand surgeries, preoperative screening of radial artery harvesting for myocardial revascularization and in arterial interventions that include radial artery cannulation and radial artery forearm flap [3]. The objective of present study was to study the morphological variations of SPA in adult human. The clinical implications of these are emphasized with relevant review of literature.

Aim and objectives:

To determine the variations in the formation of superficial palmar arch in hand.

2. Review of Literature

According to one of the extensive studies conducted on 1200 formalin fixed hands, by Coleman and Anson in 1961, the variations in the SPA were classified as complete and incomplete arches which were further subdivided into various subtypes as follows.

GROUP I – Complete Arch: Type A: classical radio ulnar arch, Type B: Ulnar arch, Type C: mediano - ulnar arch, Type D: radio - mediano - ulnar arch, Type E: ulnar artery & a branch from deep arch. GROUP II – Incomplete Arch: Type F: radial and ulnar arteries without anastomosis, Type G: only ulnar artery without supply to thumb and index finger, Type H: ulnar and median arteries without anastomosis, Type I: Median, radial and ulnar arteries without anastomosis.

In 2005 Marios Loukas et al dissected 200 hands derived from 100 formalin - fixed cadavers in order to identify arterial patterns and he found that a complete superficial palmar arch (SPA) was found in 90% of the cases and divided into 5 types, while the remaining 10% possessed an incomplete palmar arch.

In 2007 Süleyman Murat Tagil et al conducted a study on 50 (28 right and 22 left) formalin fixed hands were used. The variations observed were classified as per Coleman and Anson 1961, classification of the superficial palmar arch. complete arch of type A was seen in 41 hands (83%) and of type B in 2 hands (4%). In his study incomplete arch was seen in 3hands (6%).

In 2003 Silvia et al studied on the variations in the formation of superficial palmar arch in 30 cadaveric hands. He observed that 18 cases (60%) showed anastomosis among the arteries that form the arch and 12 cases (40%) did not. Concerning about the arterial contribution for the arc formation, the following results were obtained: 11 cases (36, 67%) were formed by the anastomosis of the ulnar artery with the superficial branch of the radial artery; 7 cases (23%) were formed by the ulnar artery only.

In 2006 Brent et al documented a case report on the unilateral absence of superficial palmar arch in the left hand.

3. Materials and Methods

Study was performed in the department of Anatomy at SreeMookambika Institute of medical sciences, Kulasekharam, Tamilnadu. Both right and left palms of 50 formalin - preserved cadaveric hands were dissected. The limbs were fixed in 10% formalin solution. The upper limbs were devoid of any injury or deformity. The dissection of the hand was performed as per Cunningham's manual of practical anatomy [4]. The limbs were dissected from the level of the wrist joint on the palmar aspect till the web spaces, superficial branches of radial and ulnar arteries were identified, and the branching pattern and course were traced. The morphology of SPA was studied and variations were noted.

4. Results

SPA was seen in all the 50 hands (100%) dissected (25 right, 25 left). Out of the 50 hands, complete arch was seen in 46 hands (24 right and 22 left) and incomplete arch in 4 hands. As per Coleman and Anson classification, complete arch of type A was seen in 43 hands (86%) and of type B in 3 hands (6%). Between the incomplete arches, 3 were of type F (6%) and 1 was of type H (2%) (Tab.1)

Table 1: Incidence percentage of variations in the current study

Arch type	No: hands	Percentage
Complete arch	46	92
Type A	43	86
Type B	3	6
Incomplete arch	4	8
Type F	3	6
Type H	1	2

Most of the arches seen in the current study were of type A (Fig.2), formed by the ulnar artery and completed on the radial side either by the superficial branch of the radial artery or princeps pollicis artery or radialis indicis artery, branches of radial artery. Only ulnar artery formed the arch (Fig.3) in only 3 hands and ulnar & radial without anastomosis (Fig.4) in 3 hands. Persistent median artery supplying the radial side of the palm and digits (Fig.5) was seen in only one hand.

5. Discussion

The normal arterial blood supply to the human hand is well documented, although the vascular supply to the hand and digits via the SPA is known to be variable (Al - Turk & Metcalf, 1984; Iossifidis, 19954, Ikeda et al, 1988, Onderoglu et al, 19975). The systematic arterial patterns of the hand were first described by Jaschtschinski, 18976. Various anomalous patterns in the arterial arches have been studied and various classifications based on the contribution from the formative branches, mainly superficial branches of the radial artery and ulnar artery have been proposed by various authors.

SPA was seen in all the 50 hands (100%) dissected (25 right, 25 left) unlike Brent et al⁷ (2010) who reported a case of unilateral absence of the SPA in one hand he observed. Complete arch was seen in 92% of the hands (46, 22 left and 24 right) in the current study. These results are similar to those reported by MariosLoukas et al (2005)⁸, who observed the presence of 90% complete arches in his study. Although complete arches seem to be more prevalent, as observed in the present study, in most of the studies done by Coleman and Anson, 1961 (78.5%), Suleyman et al, 2007 (75%)⁹, Silvia et al, 2003 (60%)¹⁰, Nicolas et al, 2010 (58%)¹¹; some authors like Valeria et al, 2004 (47.5%)¹² and Elizabeth O' Sullivan et al, 2002 (46.8%)¹³ lesser incidence of complete arches was reported.

The classical radio - ulnar arch formed by ulnar artery and the superficial branch of radial artery or princeps pollicis artery or radialis indicis artery (Coleman and Anson, 1961, Type A) was seen in 43 hands (86%, 21 left and 22 right) in the current study unlike other authors (Silvia et al, 2003, 67%; Suleyman et al, 2007, 40%; MariosLoukas et al, 2005, 40% and Coleman and Anson, 1961, 34%) who have reported a lesser incidence of the same type.

The ulnar type of arch formed by the ulnar artery alone (Coleman and Anson, 1961, Type B) was seen in 3 hands (6%, 2right and 1 left) in the present study. In comparison such an arch was more prevalent in other studies such as Coleman and Anson, 1961, 37%; Suleyman et al, 2007, 35%; MariosLoukas et al, 2005, 35%; Silvia et al, 2003, 23%.

In this study incomplete arch was seen in 4 hands (8%, 1 right and 3 left) similar with Marios Loukas et al, 2005, who reported it in 10% of his study and unlike other authors (Elizabeth O' Sullivan et al, 2002, 53.2%; Valeria et al, 2004, 52.5%; Nicolas et al, 2010, 42%; Silvia et al, 2003, 40%; Suleyman et al, 2007, 25% and Coleman and Anson,

1961, 21.5%, who have reported increased occurrence of the same.

The most consistent incomplete arch was ulnar and radial arteries without anastomosis (Coleman and Anson, 1961, Type F), seen in 3 hands in this study (6%, 2 left and 1 right hands). This type was seen in 3.2% of the hands by Coleman and Anson, 1961; in 20% of the hands by Suleyman et al, 2007 and in 33% of the hands by Silvia et al, 2003.

Only one of Coleman and Anson, Type H, in which median and ulnar arteries supplied the palm without anastomosis, was observed in the current study (2%, left hand). Whereas Coleman and Anson reported 3.8% of the same type and Silvia et al, 10 %. The other types of arches described by Coleman and Anson (Types C, D, E, G and I) were not observed in the current study.

6. Summary and Conclusion

The superficial and deep palmar arches account for a rich anastomosis between arteries of the palm. Wounds of the palm bleed profusely but heal rapidly because of this anastomosis. An injury in the ulnar artery or the SPA may compromise the arterial supply of the fingers, particularly if there is an insufficient anastomosis between the superficial and deep palmar arches. The sound knowledge about the vascular patterns in the palm is crucial in microsurgical procedures of hand and in amputations and in the choice of using the radial artery for coronary bypass graft and in preventing possible complications during hand surgery. Identifying the presence of median artery and its participation in the arch completion is important in ligation of radial or ulnar artery in case of vascular trauma.

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Pictures

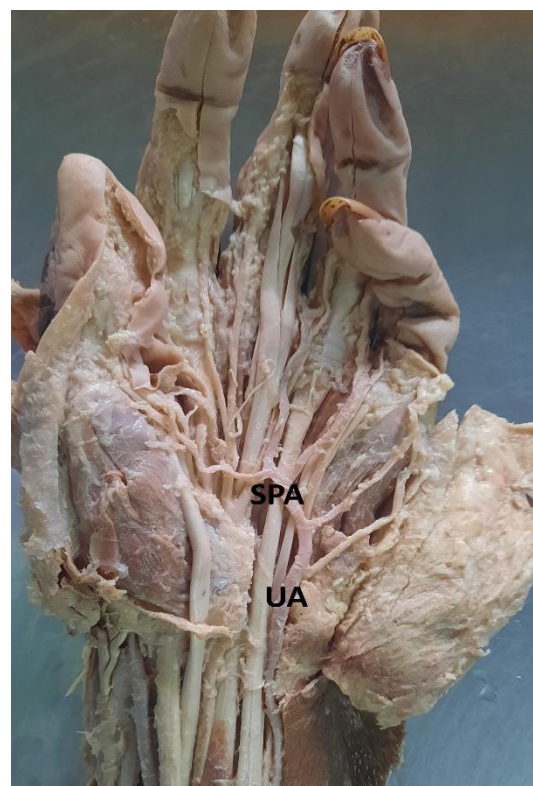


Figure 1: Complete arch, Type A – Classical radio ulnar arch. (SPA: superficial palmar arch, UA: Ulnar artery)



Figure 2: Complete arch, Type B – Ulnar arch (UA: Ulnar artery)

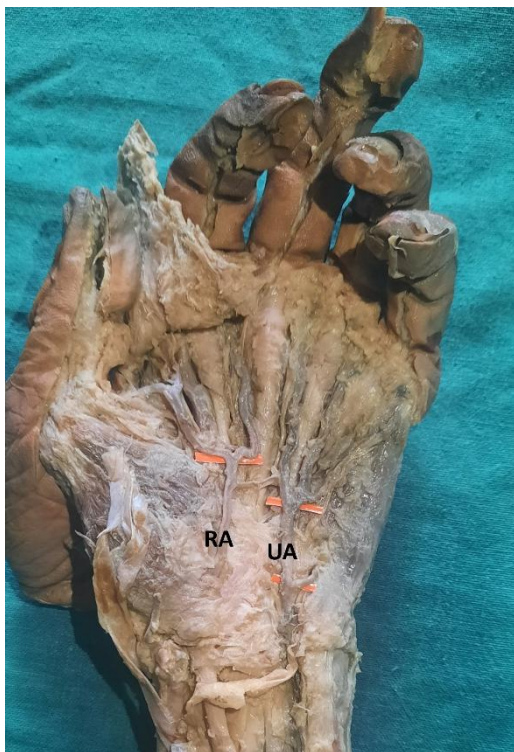


Figure 3: Incomplete arch, Type F – Radial and ulnar arteries without anastomosis (UA: Ulnar artery, RA: Radial artery).